

# elements of entomology

H. Lewin Devasahayam



---

# **Elements of Entomology**

## **BASIC CONCEPTS**

---

**H. LEWIN DEVASAHAYAM**

Associate Professor of Plant Pathology (Retd.)  
Tamil Nadu Agricultural University  
Coimbatore, Tamil Nadu



**NEW INDIA PUBLISHING AGENCY**

New Delhi – 110 034





**NEW INDIA PUBLISHING AGENCY**

101, Vikas Surya Plaza, CU Block, LSC Market

Pitam Pura, New Delhi 110 034, India

Phone: + 91 (11)27 34 17 17 Fax: + 91(11) 27 34 16 16

Email: [info@nipabooks.com](mailto:info@nipabooks.com)

Web: [www.nipabooks.com](http://www.nipabooks.com)

Feedback at [feedbacks@nipabooks.com](mailto:feedbacks@nipabooks.com)

© Author, 2013

**ISBN: 978-93-81450-63-5**

All rights reserved, no part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise without the prior written permission of the publisher or the copyright holder.

This book contains information obtained from authentic and highly regarded sources. Reasonable efforts have been made to publish reliable data and information, but the author/s, editor/s and publisher cannot assume responsibility for the validity of all materials or the consequences of their use. The author/s, editor/s and publisher have attempted to trace and acknowledge the copyright holders of all material reproduced in this publication and apologize to copyright holders if permission and acknowledgements to publish in this form have not been taken. If any copyright material has not been acknowledged please write and let us know so we may rectify it, in subsequent reprints.

**Trademark notice:** Presentations, logos (the way they are written/presented), in this book are under the trademarks of the publisher and hence, if copied/resembled the copier will be prosecuted under the law.

Composed, Designed and Printed in India

---

# Contents

---

<i>Preface</i> .....	<i>v</i>
<i>List of figures</i> .....	<i>vii</i>
<i>List of appendices</i> .....	<i>xiii</i>

## Part - I: Fundamentals of Entomology

<b>1. History of Entomology</b> .....	<b>1-13</b>
Position of insects in the animal kingdom	5
Characters of organisms belonging to Phylum-Arthropoda	6
Classification of Phylum-Arthropoda	7
Dominance of insects over other living creatures	9
<b>2. Morphology of Insects: Body Wall, Skin, Integument or Exoskeleton</b> .....	<b>15-44</b>
Cuticular processes, appendages or outgrowths	18
Body regions of insects	18
Head	18
Important structures of the head	20
Eyes	21
Antennae	21
Mouthparts	23
Biting and chewing type or mandibulate type of mouthparts	24
Suctorial mouthparts	25
Piercing and sucking type of mouthparts	26
Siphoning type of mouthparts	28
Chewing and lapping type of mouthparts	29
Sponging type of mouthparts	30
Thorax	31
Thoracic appendages	32
Legs	32
Prolegs	36
Wings	36
Abdomen	41
External female genitalia of grasshopper	43
External male genitalia of grasshopper	43

<b>3. Anatomy of Insects .....</b>	<b>45-80</b>
The digestive system or alimentary system	46
Process of digestion	49
The excretory system	51
The circulatory system	52
The nervous system	55
The endocrine system	57
The exocrine system	59
The respiratory system	62
The reproductive system	66
The female reproductive organs	66
The male reproductive organs	68
Types of reproduction	70
Sense organs in insects	72
Sound producing organs	79
Light producing organs	80
<b>4. Development and Metamorphosis .....</b>	<b>81-94</b>
Types of larvae	85
The pre-pupa or pharate pupa	87
The pupa	87
Types of pupae	88
The adult or imago	88
Metamorphosis in grasshopper	89
Metamorphosis in butterfly ( <i>Danaus chrysippus</i> )	93
<b>5. Adaptations for Survival, Offence and Defence .....</b>	<b>95-110</b>
Insect ecology	98
Orientation and tropism	106
Nature of insects	108
Natural balance or biotic balance	109
<b>6. Classification of Living Organisms .....</b>	<b>111-176</b>
Classification of insects	112
Class - Insecta (Hexapoda)	112
Subclass - Apterygota or Ametabola	113
Order 1 - Protura (Proturans)	113
Order 2 - Thysanura (Silver fish and Bristle tails)	113
Order 3 - Collembola (Spring tails)	114
Subclass - Pterygota or Metabola	114
Division - Exopterygota or Heterometabola	114
Subdivision - Hemimetabola	114
Order 1 - Odonata (Dragon flies and Damsel flies)	114
Order 2 - Ephemeroptera (May flies, Day flies etc.)	115
Order 3 - Plecoptera (Stone flies)	116
Subclass - Pterygota or Metabola	117
Division - Exopterygota or Heterometabola	117



Subdivision - Paurometabola	117
Order 1 - Dictyoptera (Cockroaches and Mantids)	117
Order 2 - Orthoptera (Grasshoppers, locusts, crickets)	118
Order 3 - Phasmida (Stick insects, leaf insects)	122
Order 4 - Dermaptera (Earwigs)	123
Order 5 - Embioptera (Web spinners, Embids)	123
Order 6 - Isoptera (Termites)	124
Order 7 - Psocoptera (Psocids, book lice and bark lice)	127
Order 8 - Mallophaga	128
Order 9 - Siphunculata or Anoplura (Sucking lice)	128
Order 10 - Hemiptera (Bugs, hoppers etc.)	129
Order 11 - Thysanoptera (Thrips)	140
Subclass - Pterygota or Metabola	141
Division - Endopterygota or Holometabola	141
Order 1 - Neuroptera (Alder flies, lacewings, ant lions)	141
Order 2 - Mecoptera (Scorpion flies)	143
Order 3 - Lepidoptera (Butterflies, skippers and moths)	143
Order - 4 - Trichoptera (Caddis flies)	153
Order 5 - Diptera (True flies and mosquitoes)	154
Order 6 - Siphonaptera or Aphaniptera (Fleas)	159
Order 7 - Hymenoptera (Ants, bees, wasps)	160
Order 8 - Coleoptera (Beetles, weevils)	165
Order 9 - Strepsiptera (Stylopids)	176

## Part - II: Economic Entomology

<b>7. Economic Role of Insects</b>	<b>177-185</b>
Pests	177
Insect pests	178
Pests causing direct damage to crops and crop produce	178
External feeders - Biting pests	178
External feeders - Sucking pests	179
Internal feeders	180
Soil inhabiting pests	182
Storage pests	182
Insects causing indirect damage	183
<b>8. Beneficial Insects</b>	<b>187-233</b>
Productive insects	187
Honeybees ( <i>Apis</i> species)	187
Bee keeping	195
Honey	203
Enemies of honeybees	205
Diseases of honeybees	206
Bee poisoning	208

Silkworms	209
Silk	209
The mulberry silkworm ( <i>Bombyx mori</i> )	210
Diseases of silkworms	212
The Eri silkworm ( <i>Philosamia ricini</i> )	214
The Tassar silkworm ( <i>Antheraea paphia</i> and <i>A. prolei</i> )	214
The Muga silkworm ( <i>Antheraea assamia</i> )	215
Lac insect ( <i>Kerria lacca</i> / <i>Laccifer lacca</i> )	215
Lac cultivation	216
Uses of shellac	218
Natural enemies of lac insect	219
Minor productive insects	219
Helpful insects	220
Classification of insect pests	223
Pest outbreak	225
Need for pest control	227
Pest monitoring	227
Forecasting pest outbreak	228
Forewarning of pest occurrence	229
Assessment of insect population	229
Estimation of damage caused by insect pests	231
Economic threshold level	233
Economic injury level	233

<b>9. Collection and Preservation of Insect Specimens .....</b>	<b>235-240</b>
Equipments necessary for making insect collection	235
Killing of insects	237
Mounting and preserving insect specimens	238
Protecting insect collections from other insects and fungi	240

## Part-III: Principles of Pest Management

<b>10. Pest Control .....</b>	<b>241-275</b>
Natural control	242
Climatic conditions	242
Physical or topographic factors	243
Natural enemies	243
Disease causing organisms or parasites	244
Applied control or Artificial control	244
Prophylactic methods	244
Curative or direct methods	246
Cultural methods	246
Physical methods	248
Mechanical methods	249
Use of natural agencies	250
Legal control	250

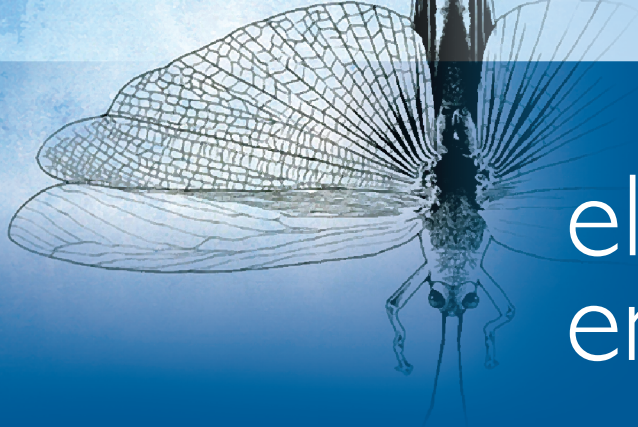
Biological control	253
Chemical control	263
Other modern methods	264
Integrated control	270
<b>11. Pesticides .....</b>	<b>277-322</b>
Insecticide formulations	278
Classification of insecticides	282
Inorganic compounds	284
Organic compounds	287
Organic compounds of animal origin	288
Organic compounds of plant origin	288
Synthetic organic compounds	292
Dinitrophenols	292
Organochlorine compounds or Chlorinated hydrocarbons	292
Organophosphorus compounds (Systemic)	297
Carbamates	298
Synthetic pyrethroids	300
Other organic compounds	301
Fumigants	302
Systemic insecticides	305
Resistance to insecticides	306
Insecticide resistance management	307
Preparation of insecticidal spray fluids	307
Precautions in handling pesticides	309
Hazards in the use of pesticides	312
Pesticide residues	314
Factors influencing effectiveness of insecticides	316
Pesticide poisoning	317
Toxicology	319
Bioassay of pesticides	321
Compatibility of plant protection chemicals	321
<b>12. Plant Protection Appliances .....</b>	<b>323-340</b>
Sprayers	323
Dusters	335
Other plant protection appliances	337

## Part-IV: Nematology and Acarology

<b>13. Nematology .....</b>	<b>341-387</b>
History of Nematology	341
Economic importance of phytonematodes	343
Nature of injury caused by nematodes	345
Symptoms of nematode injury to crops	346
Types of parasitism	346



Morphology and anatomy of nematodes	348
Head	350
Body	350
The alimentary canal	351
Nervous system	354
Excretory system	355
Reproductive system	356
Biology of nematodes	358
Host-parasite relationship	359
Taxonomy	360
Class - Secernentea	360
I. Order - Tylenchida	361
II. Order - Aphelenchida	363
Class - Adenophorea	364
Order - Dorylaimida	364
Important Genera of nematodes - general characters	365
<b>14. General Control Measures of Nematodes</b>	<b>389-398</b>
Cultural methods	389
Physical methods	393
Chemical control	393
Biological control	396
Nematodes as bio-control agents	397
<b>15. Acarology (Plant Mites or Spider Mites)</b>	<b>399-404</b>
Tetranychid mites	400
Eriophyid mites	402
Control of mites	404
<b>16. Appendices (1-15)</b>	<b>405</b>
<b>17. References</b>	<b>421</b>
<b>18. Glossary of scientific terms</b>	<b>423</b>
<b>Index</b>	<b>439</b>



# elements of entomology

Readership : Entomologist, Plant Pathologist, Nematologists and Agricultural professionals as a whole.

Acquiring knowledge about different aspects of entomology is of vital importance in adopting appropriate measures for the control of pests and also for utilizing the beneficial insects for the benefits of man. This book deals with the basic concepts of entomology, which include:-

- Morphology, anatomy, adaptation and classification of insects, especially the parasitic ones, which do harm to plants, livestock and even to man.
- Economic role of insects with special reference to productive ones such as, honeybee, silk worm and lac insect as well as beneficial ones such as, parasitoids, predators pollinators etc.
- Pest management that covers usage of various plant protection chemicals, plant protection equipments, toxicology of pesticides, compatibility of pesticides etc.
- Non-insect pests viz., nematodes and mites, their economic role and control measures.

The text is substantiated with many fine, hand-drawn figures and illustrations that will help better understanding of the text. The book, which is primarily intended for the undergraduate students of agriculture, will be of use to the postgraduate students of agriculture, to the officials working in the department of agriculture, especially those involved in plant protection work and also to the elite public who are interested in scientific agriculture.

**2014, 458 pages, figs., tabs., 25 cm**

**H. Lewin Devasahayam**, Associate Professor of Plant Pathology (Retd.)  
Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu.



**NEW INDIA PUBLISHING AGENCY**

101, Vikas Surya Plaza, CU Block, L.S.C. Market  
Pitampura, New Delhi-110 034, India  
Tel. : +91(11) 27341717, Fax : +91(11) 27341616  
E-mail : [info@nipabooks.com](mailto:info@nipabooks.com)  
Web : [www.nipabooks.com](http://www.nipabooks.com)

ISBN 9789381450635